FINAL REPORT FOR YEAR 1--CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY--DEPARTMENT OF PESTICIDE REGULATIONS

SUBMITTED: 31 March 1997

TITLE: Integrated Management of Soil Borne Diseases and Aphid Transmitted Viruses in California Vegetable Crops--An on Farm Demonstration

PRINCIPAL INVESTIGATORS:

Charles G. Summers
Department of Entomology
University of California
Kearney Agricultural Center
Parlier, CA 93648
(209) 646-6500

James J. Stapleton
IPM Project
University of California
Kearney Agricultural Center
Parlier CA 93648
(209) 646-6500

EXECUTIVE PROJECT SUMMARY:

Reflective mulches were used successfully in several on farm trials in commercially grown spring tomatoes, and fall planted pumpkins, zucchini squash, and cucumbers in the San Joaquin Valley to reduce the incidence of aphid-borne virus diseases and squash silverleaf. While the incidence of virus was generally low in the spring planted tomatoes, the mulched portion of the field (20 acres) had 50% fewer virus infected plants than did the unmulched portion of the field. In a fall pumpkin field, the incidence of virus infected plants was 19% in the mulched portion and 100% in the unmulched portion of the field one month before harvest. Yields from the mulched portion of the field were three (3) time those from the unmulched portion of the field and individual pumpkins weighted approximately 6 times more (12 pounds versus 2 pounds). In fall planted zucchini squash, both the incidence and total amount of virus present was less on the mulched portion of two fields when compared to the unmulched portion of the same fields. In one field, harvest was 5 days earlier in the mulched portion of the field. Yields in that same field are approximately 1.5 times higher in the mulched than in the unmulched portion of the field. In a fall planted cucumber field, both the incidence of virus disease and silverleaf whitefly density was less in plants grown over reflective mulch compared to plants grown over unmulched soil. Yields from the mulched portion of the field are 3.7 times higher than those from the unmulched area in the same field. Fruit was ready for harvest on the mulched portion of the field approximately 10-14 days earlier than on the unmulched portion. Mulching alternate rows reduced the incidence of both virus diseases and silverleaf whitefly density but yields were not as high as where every planting bed was mulched. The reduction in cost however may make this a economical strategy. Insecticides were applied 5 times to the unmulched portion of the field for silverleaf whitefly control and no applications were made to the mulched area of the field.

A trial is currently underway which combines soil solarization for the control of soil borne pathogens and reflective mulch for the management of aphid borne virus diseases. Initial results indicate that yields in plots solarized with clear plastic for four weeks and then painting that plastic silver to repel aphids and whiteflies resulted in a three fold increase in mature green fresh market tomatoes over unsolarized, non-reflective plots. This technique offers the advantage of controlling both soil-borne pathogens and virus diseases with on application of plastic mulch, thereby considerably reducing costs.

By working with representatives of the packing houses, with whom the grower cooperators contract, we have involved key people in the agricultural community in demonstrating the effectiveness of this strategy. Also, the growers selected are key leaders in the agricultural community and are highly respected by other growers, and, often

imitated. This approach is far more successful that holding meetings or demonstrations. The "coffee shop" meetings are more likely to produce results that those held by researchers. This approach leads to the development of grower based IPM groups.

We have personally spent a considerable amount of time with all of the growers involved in the project. We have explained the science behind the concept of using reflective mulches and have also shared the results on a weekly basis. This is somewhat unique for the researchers who developed the management strategies to be so heavily involved in their implementation.

A workshop/field demonstration is scheduled for June/July 1997 to update growers and train them in the proper use of mulch culture. This workshop is scheduled to train growers in advance of the fall planting season and also with sufficient advanced training that those wishing to use solarization as part of their fall planting preparation may do so. A tentative schedule is attached to this report. The program is not finalized but DPR will be notified as soon as the program is complete and their participation is requested.

SUMMARY OF PROGRESS BY OBJECTIVE:

OBJECTIVE 1: To utilize reflective mulches to prevent or delay the onset of aphid transmitted viruses to squash, melons, tomatoes, and peppers in California . . . and to train growers industry, and PCA's in the utilization of this technique.

Commercial plantings, in conjunction with grower and industry cooperators, of tomatoes, zucchini squash, cucumbers, and pumpkins were mulched with reflective mulches during the 1996 growing season.

Tomatoes--Procedures Twenty acres of fresh market tomatoes near Kettleman City (Cooperator--Myers Tomatoes) were mulched in the spring of 1996 using a "gray" polyethylene mulch manufactured by AEP Industries. The mulch was applied prior to planting to one side of a larger tomato field. We selected a similar 20 acre sized area in the same field on the opposite side to use as an unmulched control. Within each of the mulched and unmulched areas, six 100 plant areas were permanently marked for weekly evaluation. A yellow pan water trap was located adjacent to each "field" and aphids collected weekly and returned to the laboratory for identification. Within each sample site (the 100 plants) the number of alate (winged) aphids per leaf (this is the form responsible for carrying virus into the field) were determined by counting the number on one leaf from each plant and each plant was scored for the presence or absence of visual foliar virus symptoms. As virus symptoms developed, plants were sampled by taking 1-2 leaves from the plants, returning them to the laboratory, and ELISA was conducted to confirm the presence of a virus and to determine its identity.

Results and Discussion Aphid numbers were unusually low during the spring of 1996. Reasons for this will be discussed in the final report. Due to the low aphid numbers, the incidence of virus diseases were also lower than in previous years. Figure 1a shows the incidence of virus disease in the unmulched portion of the field. As noted, virus incidence was extremely low in the spring/summer of 1996 and only 3% of the plants were infected. Figure 1b shows the incidence of virus disease in the mulched portion of the field; only one-half as many plants were infected. While caution is advised in interpreting these data because on the low incidence of virus disease, it does demonstrate that reflective mulch did reduce the incidence of infection. Data on aphid numbers and species identification are not currently summarized and will be included in the final report.

Pumpkins--Procedures One acre of a 20 acre commercial pumpkin field in Kingsburg CA (Mike Satterstrom Cooperator) (grown for Halloween decorations) planted in early July was mulched with reflective mulch (Specialty Ag. Inc., Reedley CA) at planting. A second one acre area, approximately 200 meters from the mulched rows was selected as an unmulched control. Within each of the mulched and unmulched areas, four 25 foot long sections were marked for aphid counts and visual indexing for virus symptoms as described above for the tomato experiment. Aphids were counted weekly and plants indexed for virus symptoms weekly. A yellow pan water trap was located adjacent to each "field" and aphids collected weekly and returned to the laboratory for identification. As virus symptoms developed, plants were sampled and leaves returned to the laboratory for processing by ELISA to confirm the presence of a virus and to determine its identity. At maturity, pumpkins from the four areas within the mulched and unmulched portions of the field were harvested and yields determined.

Results and Discussion Aphid counts and the weekly increase in percent virus incidence in the mulched and unmulched portions of the field have been completed but aré not yet summarized for this progress report. The incidence of virus infected plants is shown in Fig. 2. By 23 August 1996, 100% of the plants in the unmulched area of the field were infected with one or more viruses while only 19% of the plants grown over reflective mulch were infected (Fig. 2). Seventy (70) percent of the plants were infected with zucchini yellow mosaic virus (ZuYMV), 100 % with watermelon mosaic virus 2 (WaMV-2), 5% with cucumber mosaic virus (CMV) and 5% with alfalfa mosaic virus (AMV). The mulched portion of the field yielded 545 pounds of pumpkins in 100 row feet while the unmulched section yielded only 173 pounds per 100 row feet. In the mulched portion, the average weight per pumpkin was 12.4 pounds and in the unmulched portion, the average weight per pumpkin was only 2.8 pounds.

Squash--Procedures Two fall planted commercial squash fields were evaluated in 1996, one in Parlier (Gorge Kubo Cooperator) and one in Caruthers CA (Albert Solis, Cooperator). Both fields were planted on approximately 1 September 1996. One (1) acre in each field (approximately three acres total in each field) was mulched at planting (approximately 1 September 1996) with reflective mulch (Specialty Ag. Inc., Reedley CA). Four (4) 25 plant areas in each of the mulched and unmulched sections were marked for virus incidence determination and yield determination prior to virus symptoms becoming evident. Virus incidence was recorded weekly and yield data collected beginning with the first harvest. We also found that the reflective mulch significantly reduced invasion by the silverleaf whitefly and significantly delayed the onset of silverleaf symptoms in squash. Both adult and immature whitefly counts were taken approximately 4 times during the season on the cucumbers and the incidence of silverleaf was recorded weekly in the squash. Whitefly counts were not takes in the squash since as few as three nymphs per leaf can produce silverleaf symptoms and adults do not cause silverleaf symptoms (Yokomi et al. 1990).

Results and Discussion As of October 16, 1996, the incidence of virus disease in the squash field at Caruthers was 59% in the unmulched portion of the field and 4% in the mulched portion. Yield data are not available at this time. The weekly development of virus symptoms in the mulched and unmulched portions of the field are shown in Fig. 3. It should be noted that mulching had two primary effects: (1) plants grown over mulched began to show symptoms of virus infection two weeks later that did plants in the unmulched portion of the field, (2) the percentage of infected plants was significantly less during the season in the mulched portion of the field. By 23 October 1996, 60% of the plants in the unmulched portion of the field were virus infected while < 10% of the plants grown over mulch were infected. The weekly development of virus symptoms in the mulched and unmulched portions of the Parlier field are shown in Fig. 4. Virus symptoms developed in a similar manner in the Parlier squash trial, however, the development of symptoms in plants grown over mulch was delayed approximately three weeks. Also, the incidence of disease reached 100% by 10 October 1996 in the unmulched portion of the field while only 20% of the plants grown over mulch became infected throughout the season. A light frost on 25 October resulted in sufficient injury to terminate both fields. We did not see any difference in the degree of frost injury between the mulched and unmulched portions of the field. After 9 harvest in the Parlier squash field, total yield from a 100 plant area in the mulched section of the field is 311 pounds and the yield from a 100 plant area in the unmulched portion of the field is 216 pounds. Currently, plants in the mulched portion of the field are yielding approximately twice the volume of fruit as those in the unmulched portion. This is due to the decrease in productivity of the plants in the unmulched section due of infection by multiple viruses. In addition, fruit in the mulched portion of the field was ready for harvest 5 days earlier than was fruit in the unmulched portion of the field. The results of this commercial experiment agree well with those reported by Summers et al. (1995) under small plot experimental conditions.

The development of silverleaf symptoms in the mulched and unmulched portions of the Parlier field is shown in Fig. 5. As with the development of virus symptoms, the reflective mulch both delayed the onset on silverleaf symptoms and significantly decreased the overall percentage of plants showing silverleaf symptoms. The effectiveness of the mulch in reducing both the incidence of virus diseases and of silverleaf symptoms is shown in Photo 1. Silverleaf symptoms did not develop in the Caruthers field since silverleaf whiteflies were not present at that location.

Cucumbers--Procedures A 5 acre commercial cucumber field in Parlier was included in this experiment. Approximately 1.5 acres were mulched with reflective mulch (Specialty Ag. Inc. Reedley CA) prior to planting. On an additional 1 acre, every other row was mulched with reflective mulch leaving the alternate rows unmulched. This was done to determine if mulching only every other row would provide sufficient protection of the adjacent unmulched row, thus cutting the cost by one-half. The remaining 2.5 acres was unmulched. Four (4) 25 plant areas were marked in each portion of the field for virus determination and whitefly counts. Virus determinations and whitefly counts were taken weekly. Yield data, from each of the 25 plant areas, has been collected since the first harvest.

Results and Discussion The incidence of virus infected plants on the mulched and unmulched portions of the field are shown in Fig. 6. The incidence of virus infected plants in the portions of the field where alternate rows were mulched is shown in Fig. 7. The incidence of virus infected cucumber plants followed a course similar to the squash. By the end of the growing season, $\approx 60\%$ of the plants in the unmulched plots were virus infected while 0% in the mulched portion of the field were infected. In the area of the field where alternate rows were mulched, this procedure protected the plants on the alternately unmulched rows from becoming infected and by the end of the season, only 2% of plants on the alternate unmulched rows were showing virus symptoms. None of the plants on the mulched rows were infected. While the incidence of virus infection is relatively high in the unmulched portion of the field, we believe that yield reductions at this time are due more to the incidence of silverleaf whitefly in the unmulched portion of the field than to virus diseases. The difference between the mulched and unmulched portions of this field are shown in Photos 2 and 3. We have taken whitefly counts but they have not yet been summarized for inclusion in the report. The grower has treated the unmulched portion of the field 5 times for whitefly control but has not needed to threat the mulched area. We consider this to be highly significant. Numbers of adults, however, are approximately 5 to 10 times higher in the unmulched portions of the field than in the mulched portions and the number of nymphs per leaf follow a similar pattern. Yields are shown in Table 1. Yields in the mulched areas, solid mulch or alternate rows mulched, are higher that those from unmulched areas. Note, however, that yield from unmulched rows, but with a mulched row on either side i.e. alternate rows mulched and unmulched, are higher than from the area completely unmulched. See Photo 3. Since these data have not yet been analyzed statistically, caution is advised in drawing conclusions. Fruit from the unmulched areas tends to be larger (weight per fruit) than is fruit from the mulched areas (Table 1). We have noticed that fruit on the unmulched rows is shorter in length but with a greater diameter that fruit from the mulched areas. The growers (who is also the packer) informs us that the pack-out from the unmulched areas is less than from the mulched areas due to poorer quality fruit--the fruit from the unmulched areas is too "short and fat" in his words

Melons--Procedures A trial was conducted to determine if placing reflective mulch on alternate melon beds was as effective in reducing the incidence of aphid borne virus diseases as mulching every bed. Also, a new technique was evaluated. There is a problem with some growers who prefer to plant by machine. This means that the plastic cannot be applied to the beds prior to plant and also, a problem develops after planting because, due to uneven spacing, holes cannot be pre-cut in the plastic. Working with one manufacturer, we have devise a plastic that has a lattice pre-cut down the center. This lattice leaves approximately two-three inch holes through which the plants can emerge. Thus, the plastic can be applied to the planting beds after planting and before the plants emerge. See Photo 3. This mulch will hereafter be referred to as "lattice." We evaluated this "lattice" plastic mulch to determine its effectiveness in repelling aphids and reducing the incidence of virus diseases. We also evaluated the repellency of this and other mulches on silverleaf whitefly. The trial was planted in late July and aphid counts, whitefly counts and the incidence of virus infection determined on a weekly basis beginning approximately 10 days after plant emergence.

Results and Discussion The incidence of virus infected plants grown over the various mulch treatments is shown in Fig. 8. All mulches, when applied the every row (continuous row mulches) significantly delayed and/or reduced the incidence of virus infection. The lattice mulch was as effective as the solid mulch in reducing the incidence of virus infection. Mulching alternate rows reduced the amount of virus compared to the unmulched plots. The highly reflective mulch (Specialty Agric.) was more effective in reducing the incidence of virus in the alternately mulched rows that was the AEP mulch. Yield data from the melon trial is shown in Table 2. These yield represent total yields over three harvests of all grades. We have not has the chance to calculated yield for each size category or complete that statistical analysis The final report will contain yields in cartons per acre for each size category and will be analyzed statistically. It is, however, possible to draw some general trends from the data pending statistical analysis. In terms of total yield, there appears to be little or no difference between any of the plots in which all rows were mulched (treatments 2, 4, and 5). Also, there appears to be no difference between the mulch cut with the lattice (treatment 2, 79 pounds per plot) and the solid mulch (treatment 5, 84 pounds per plot)--both of which has all rows mulched. Likewise, there appears to be little or no difference in the total number of fruit per plot. When alternate rows were mulched, there does appear to be a higher yield in the lattice mulch (treatment 1) compared to the AEP mulch (treatment 3). This was the mulch supplied by Specialty Agric. and was more highly reflective that the AEP mulch. This mulch treatment also had a lower percentage of virus infected plants. All mulch treatments had a higher fruit yield than the unmulched control although yield in the AEP alternate row mulch (38 pounds) may not be significantly higher that the unmulched control (36 pounds). These data suggest that while the incidence of virus disease can be reduced by mulching alternate rows, yields from plots with alternately mulched rows are not as high as those from plots in which every row is mulched. It could be that the mulch is contributing some, as of yet unknown, growth stimulation. These results were very similar to those obtained for cucumbers under commercial growing conditions.

Population levels of winged aphids (alates), those responsible for bringing virus inoculum into the field, are shown in Fig. 9. Mulching only everyother row did not reduce the incidence of alate aphids on the plants to the degree that mulching every row did. This is also reflected in the incidence of virus disease in the alternate verses continous rows being mulched although the incidence of diseased plants was considerably below that in the unmulched control plots (Fig. 10).

Levels of all stages of silverleaf whitefly was reduced by the use of reflective mulch (Fig. 11). As was observed with winged aphids, mulching all rows was significatly superior to mulching alternate rows in reducing the incidence of silverleaf whiteflies.

OBJECTIVE 2: To integrate row polarization with the use of reflectorized film for control of soil borne pathogens and aphid transmitted viruses in vegetable crops.

Tomatoes--Procedures: An experiment was conducted at the Kearney Agricultural Center on soil known to be infested with *Sclerotium rolfsii*. The following treatments were evaluated: 1. Solarization under clear plastic for 4 weeks followed by spraying the plastic with sliver reflective paint, 2. Solarization under clear plastic for 4 weeks followed by removal of plastic, 3. Solarization under reflective plastic mulch for 4 weeks, 4. Solarization under "gray" reflective plastic for 4 weeks, 5. No solarization followed by application of reflective plastic at planting, 6. Control, no solarization, no reflective mulch. The trial was planted to tomatoes (cv Shady Lady--transplants) on 24 July 1996. Irrigation was by solid set sprinklers to avoid moving inoculum between plots. The plots have been evaluated for the incidence of *Sclerotium rolfsii* and aphid borne viruses.

Results and Discussion Yields from the solarization/virus experiment are shown in Table 3. Table 3 shows that advantages of pre-plant solarization with clear plastic followed by spraying that plastic silver to make it reflective to aphids and whiteflies (treatment 4). Yields in this treatment were nearly three times those of the control.

PROBLEMS ENCOUNTERED: A number of problems were encountered this season that indicated that there is a need for more education is the use of reflective mulches as part of a pest management program (see schedule for a workshop below). One common problem was encountered during routine cultivation of crops following the application of the mulch. In two cases, too much speed was used during furrowing and hence dirt was thrown up onto the mulch thereby cutting down on the effective surface area for repelling aphids. This is evident in Fig. 1 a in which the incidence of virus infected tomato plants increased dramatically between the sample taken on 4 June and 11 June. The field was cultivated on the afternoon of 5 June and considerable soil was thrown onto the mulch, reducing its surface area by ≈ 50%. This can be corrected by slowing the tractor speed during this operation. A second problem encountered was inadequate pre-plant herbicide application hence a weed problem developed in some of the fields. Also, nut grass became a problem in some fields and came up through the mulch. We have talked to the manufacturer and suggested he can "back" the reflective plastic in black to cut down on weed emergence, particularly nut grass The manufacturer has indicated that this will be no problem to do and so we will evaluate this is the coming year. Also, plastic mulch has recently become available (from the same manufacture) that will screen-out photosynthetically active light (PAR). This should reduce or eliminate plant growth under such mulches. These will also be tested during the coming year. One grower applied the mulch wrong side up although one side was reflective silver (that side goes up) and the lower surface green (that side was to go down). This was likely a miscommunication between the grower and his field crew but it illustrates the need for additional education.

COMMUNITY BASED GROUP-IPM INVOLVEMENT and DEVELOPMENT OF GROWER BASED IPM: This project was designed to encourage the development of community-based IPM within the context of the grower community. We have, from the inception of the project, involved the packing houses and their field representatives as part of the project. They were responsible for selecting the grower cooperators used in the current year on-farm demonstrations. This is particularly important for the east side vegetable industry because most, if not all, of these growers contract to market their produce through these packers/shippers. By involving the field representatives, they had an opportunity to see first hand the value of this program both in terms of reducing virus incidence and consequently increasing yields and also in the reduction in the need for pesticides based on this program. This involvement puts them in a much "stronger" position to encourage their other growers to switch to this management strategy during the up coming years. Through our arrangements with the packing house representatives, we also chose grower cooperators who, (1) are willing to share new knowledge with their neighbors and (2) are considered to be some of the best and most progressive growers in the area. These growers are looked up to by others in the area and because of their positive experience, other growers are more likely to "join in". We will also have an opportunity to build on this during our scheduled plastic culture workshop to be held in the spring of 1997 (see below).

We have selected growers who represent a diversity in ethnic background and from corporate farming to small family farms. These individuals were selected from several locations throughout the San Joaquin Valley.

We have personally spent a considerable amount of time with all of the growers involved in the project. We have explained the science behind the concept of using reflective mulches and have also shared the results on a weekly basis. The growers have shown a great amount of interest and have assisted us in collecting yield data and taking insect and virus counts. This further involves them in what is going on a gives them a greater understanding of the processes that are occurring.

As noted below in the workshop section, a portion of the workshop will be devoted to a farmer-to-farmer forum for discussion of this years demonstrations. This years grower cooperators will be featured in this forum.

Both Drs. Summers and Stapleton are participants in the Westside BIFS project. This gives us another opportunity to increased the community based IPM that this project has helped to develop.

COOPERATORS 1996

Jeff Mitchell, Don May Vegetable Crops Specialist Kearney Agricultural Center Parlier CA. & Fresno Co.	Ron Tabata Myers Tomatoes King City CA.	Richard Maldanro Farm Advisor Fresno County
Peter B. Goodell UCIPM Project Kearney Agricultural Center, Parlier, California 93648	Joe Santellano Sunnyside Packing Selma, CA.	Dennis Mehling Silver Creek Packing Mendota, CA
Mike Satterstrom Kingsburg CA	George Kubo Parlier, CA	Alberto Solis Caruthers, CA

FIELD DAYS: A field day was held on 29 October 1996.

WORKSHOPS: A one day **workshop** is scheduled for the summer (June/July) of 1997 to better inform the growers and PCA's about how to maximize reflective mulches in their pest management programs. The problems encountered this year (see above) will be discussed and ways to avoid them presented. We feel that following this workshop, participants will have a much better understanding of how the more effectively use reflective mulches. A portion of the workshop will be devoted to a **farmer-to-farmer forum** where grower participants in this years on farm demonstrations will present their assessment of the study and interact with other growers on the advantages of this approach.

REFERENCES CITED:

Summers, C. G., J. J. Stapleton, A. S. Newton, R. A. Duncan, and D. Hart. 1995. Comparison of sprayable and film mulches in delaying the onset of aphid-transmitted virus diseases in zucchini squash. Plant Dis. 79: 1126-1131.

Yokomi, R. K., K. A. Hoelmer, and L. S. Osborne. 1990. Relationships between the sweetpotato whitefly and the squash silverleaf disorder. Phytopathology. 80: 895-900.

Table 1. Summary of total cucumber yields for 9 harvests from mulched, unmulched and alternately mulched rows in a Parlier CA trial.

Treatment	Number of Fruit	Yield in Pounds	Weight per Fruit
Mulched Rows	609	441	0.73
Unmulched Rows	117	117	1.00
Alternate Rows Mulched [a]	435	361	0.83
Alternate Rows Unmulched [b]	143	143	1.00

[a] Every other row mulched

[b] Every other row unmulched

Table 2. Summary of cantaloupe yields from reflective mulched plots, unmulched plots, and alternate row mulched plots. 1996.

Treatment	Mean		
	No. Fruit/ Plot	Pounds of Fruit/Plot	Cartons/ Acre [1]
(1) Alternate Row Lattice [a, c]	26	46	416 b
(2) Continuous Row Lattice [a, d]	40	79	667 c
(3) Alternate Row Solid [b, c, e]	23	38	363 ab
(4) Continuous Row Solid [b, d, e]	37	74	626 c
(5) Continuous Row Solid [a, d, e] (Specialty Agric.)	42	84	700 c
(6) Unmulched Control [f]	20	36	318 a

[a] Mulch from Specialty Agric. Highly reflective looks like aluminum foil but is plastic.

[b] Mulch from AEP Industries. Appear "gray" in color.

[c] Every other row mulched leaving the intervening rows unmulched.

[d] Every row mulched leaving no unmulched rows.

e Solid mulch without the center lattice. Holes were cut at each location of a plant prior to planting and mulch was applied before planting.

[f] Every row unmulched.

[1] Means followed by the same latter(s) are not significantly different at P = 0.05. Fishers Protected LSD.

Table 3. Mean weight (pounds) of mature green fresh market tomatoes in solarization/virus experiment conducted at the Kearney Agricultural Center. 1996.

Treatment	Mean weight of tomatoes per plot [a]
(1) AEP Mulch [b] Pre-plant, Mulch Remains	80.1
(2) AEP Mulch [a] Pre-plant, Mulch Removed @ Planting	51.9
(3) Clear Mulch Pre-plant, Mulch Removed @ Planting	50.8
(4) Clear Mulch Pre-plant, Sprayed Silver [c] @ Planting	118.2
(5) AEP Mulch [a] at Planting	65.0
(6) Unmulched Control	41.6

[a] Average of six replications.

[b] Mulch supplied by AEP industries. Mulch appeared "gray" to the human eye.

[c] Silver spray was highly reflective and appeared "aluminum" to the human eye.

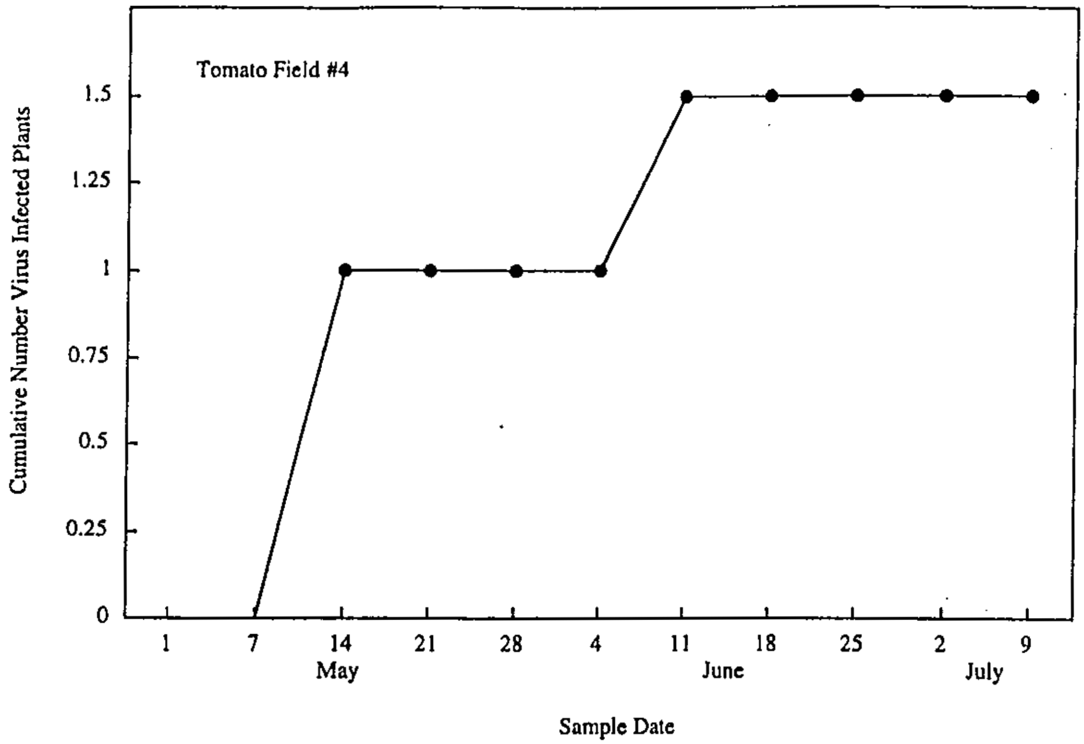


Figure 1 a. Development of virus infected fresh market tomatoes grown over reflective plastic mulch. Kettleman City, CA. 1996

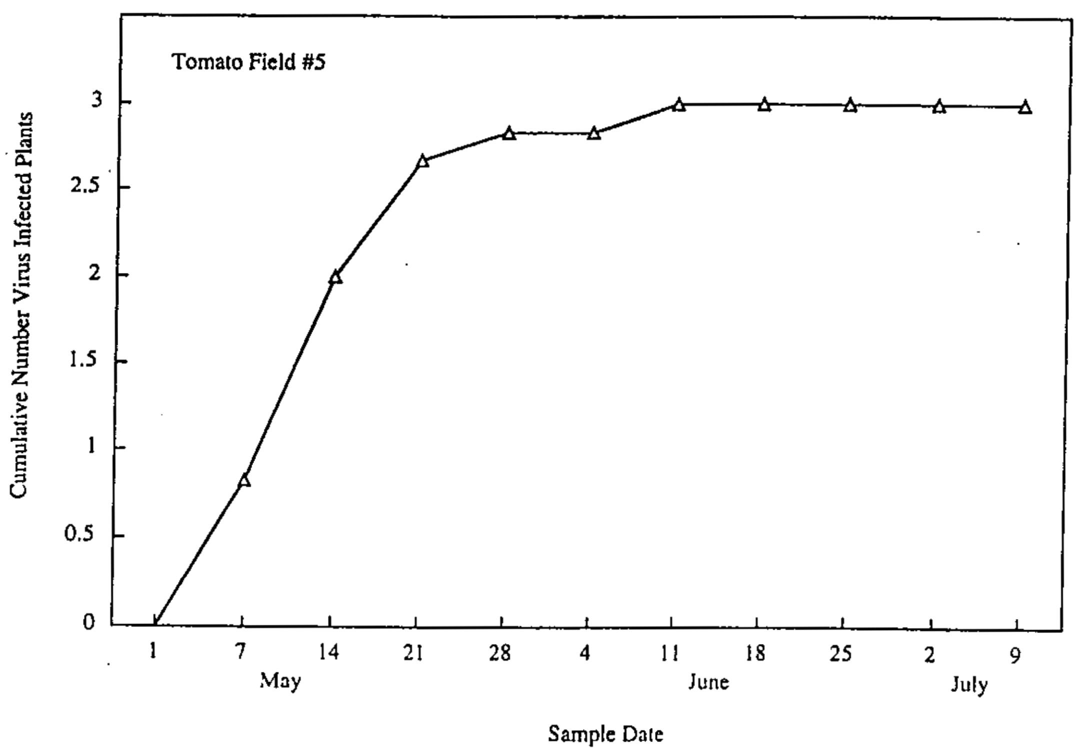


Figure 1 b. Development of virus infected fresh market tomatoes grown over bare soil. Kettleman City, CA. 1996.

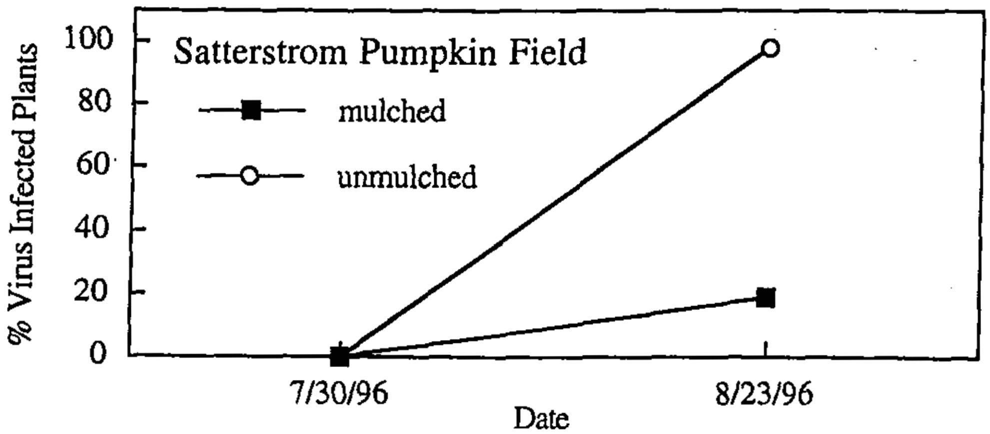


Figure 2. Development of virus infected pumpkins grown over reflective mulch and bare soil. Kingsburg, CA. 1996.

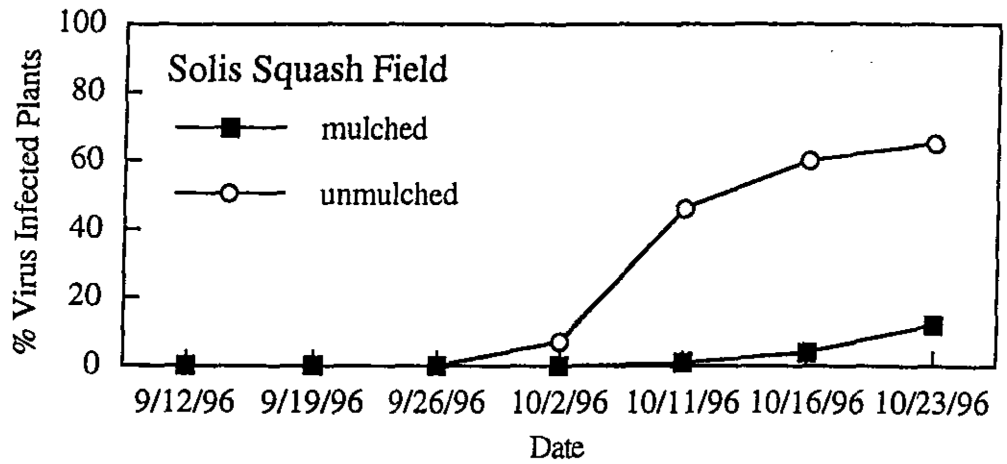


Figure 3. Weekly development of virus symptoms in fall planted zucchini squash grown over reflective plastic mulch and bare soil. Caruthers CA. 1996.

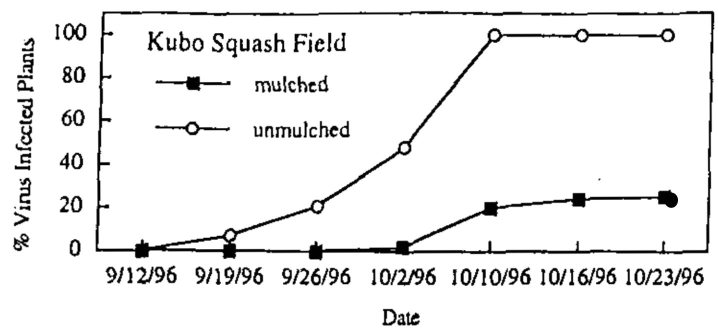


Figure 4. Weekly development of virus symptoms in fall planted zucchini squash grown over reflective plastic mulch and bare soil. Parlier, CA. 1996.

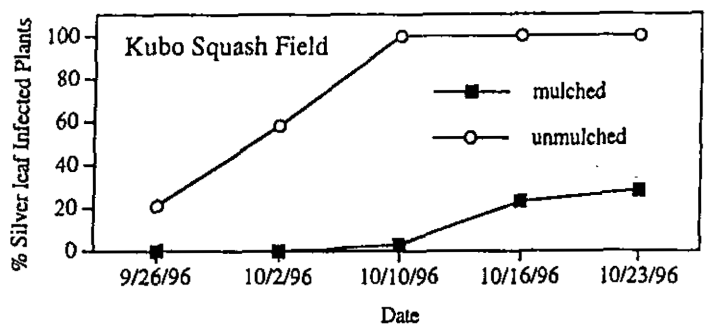


Figure 5. Weekly development of silverleaf symptoms in fall planted zucchini squash grown over reflective plastic mulch and bare soil. Parlier, CA. 1996.

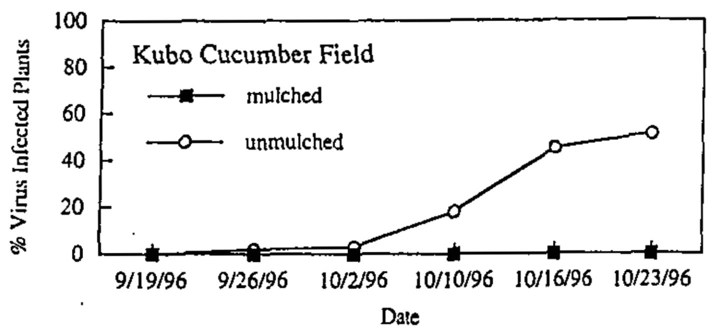


Figure. 6. Weekly development of virus symptoms in fall planted cucumbers grown over reflective plastic mulch and bare soil. Parlier, CA. 1996.

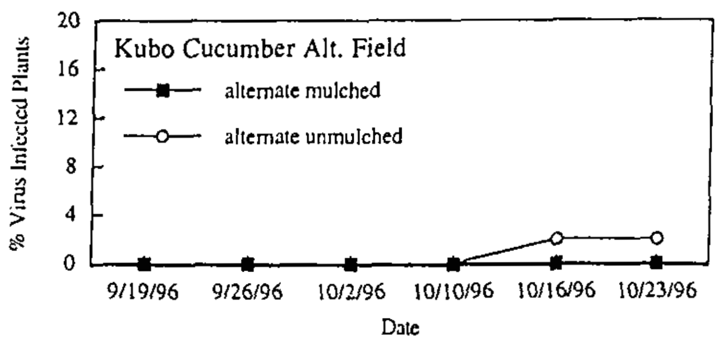


Figure 7. Weekly development of virus symptoms in fall planted cucumbers grown over reflective plastic mulch and bare soil. In this experiment, alternate beds were covered with reflective mulch leaving the intervening alternate beds mulch free (bare soil). Parlier, CA. 1996.

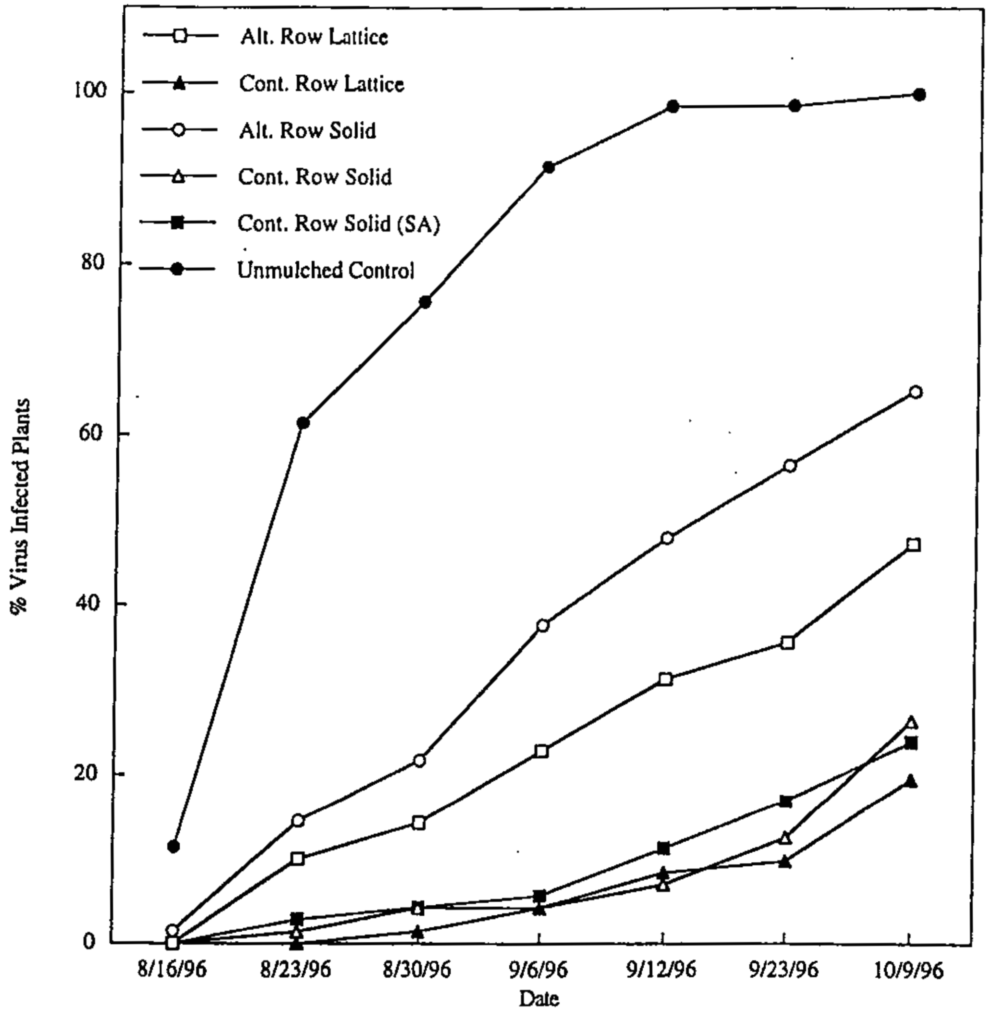


Figure 8. Weekly development of virus symptoms in fall planted melons grown over reflective plastic mulch and bare soil. Parlier, CA. 1996.

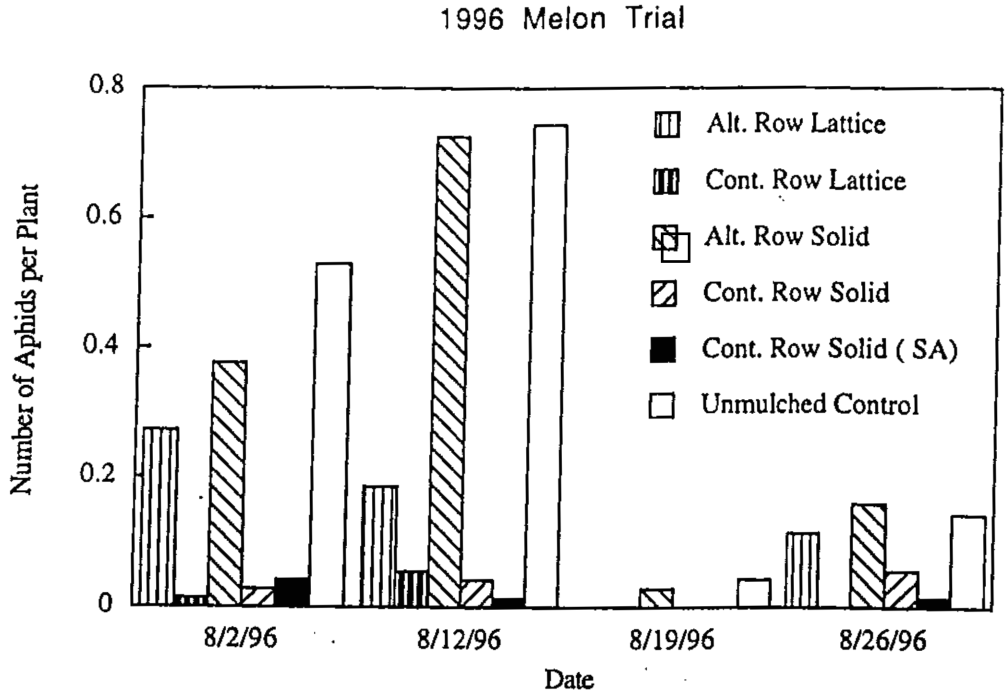


Figure 9. Populations of alate (winged) aphids on melons grown over various reflective mulch configurations. Parlier, CA. 1996

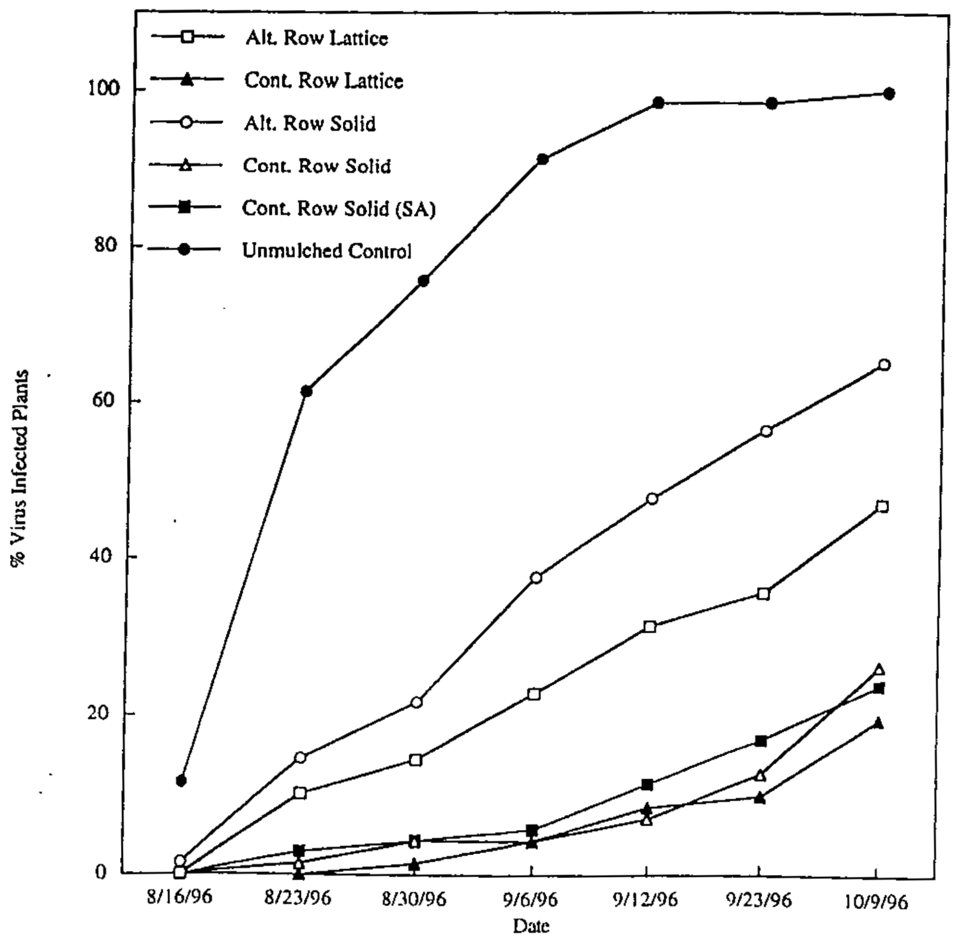
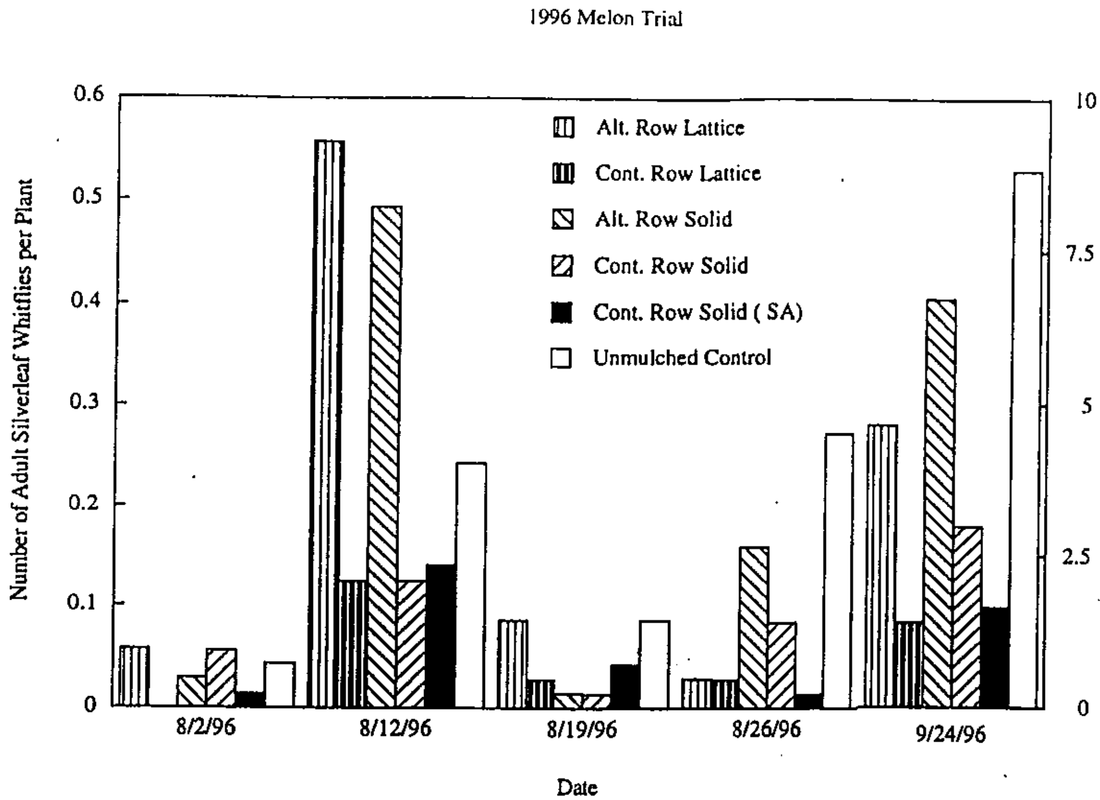


Figure 10. Incidence of aphid borne virus diseases in melons grown over various reflective mulch configurations. Parlier, CA. 1996.



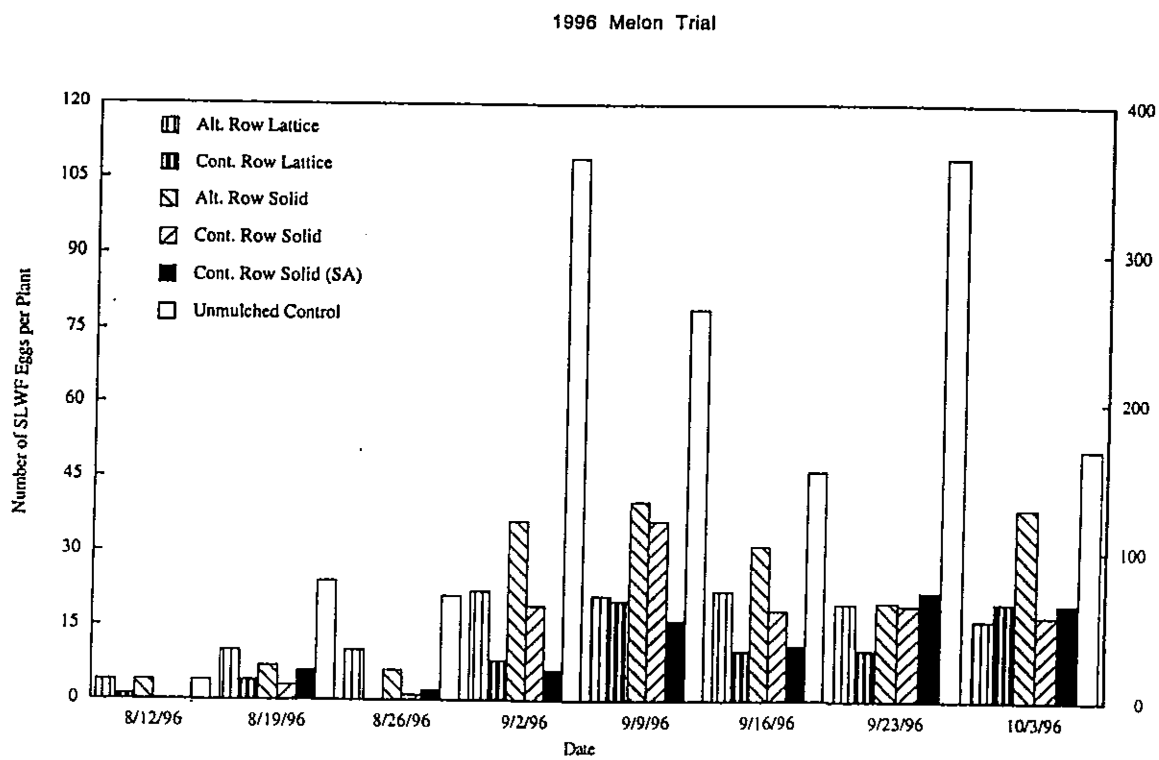
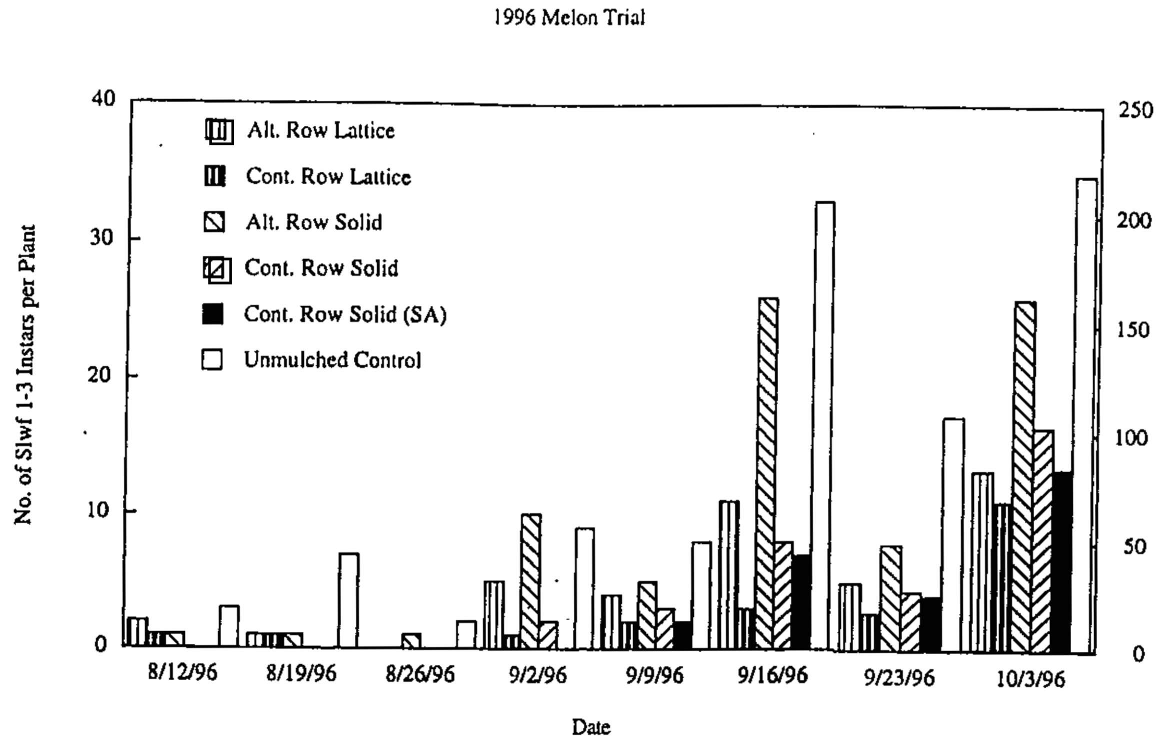


Figure 11. Population levels of various life stages of silverleaf whitefly in melons grown over various reflective mulch configurations. Parlier, CA. 1996.



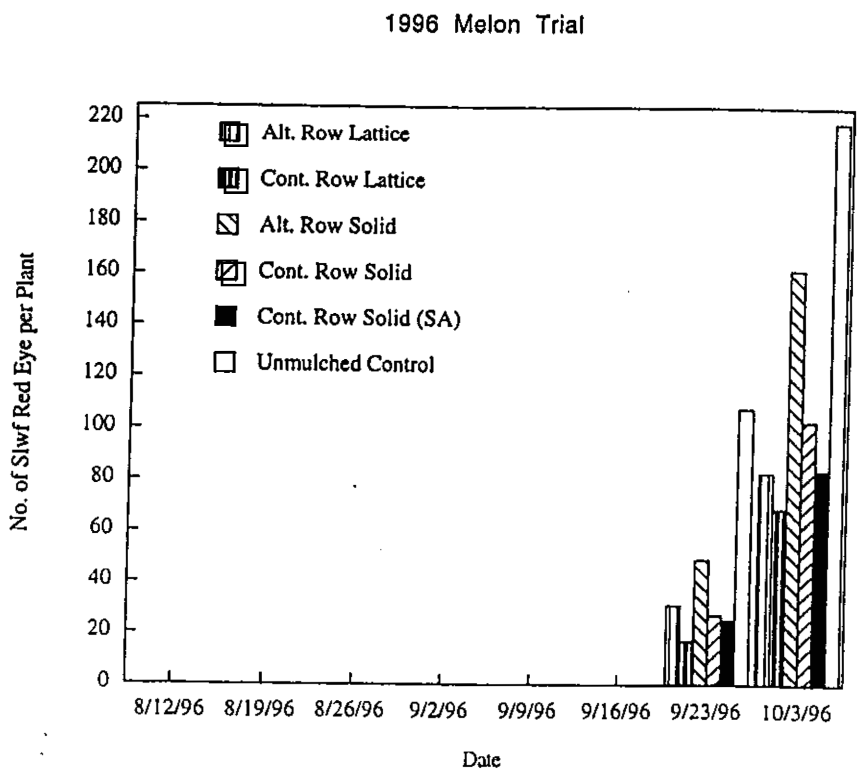


Figure 11 (cont). Population levels of various life stages of silverleaf whitefly in melons grown over various reflective mulch configurations. Parlier, CA 1996.

Photo 1. Commercial squash field in Parlier CA used to evaluate the effectiveness of reflective mulch in repelling aphids and silverleaf whiteflies thereby reducing the incidence of aphid-borne viruses and squash silverleaf. Plants in the foreground (dark green) were grown over mulch, those in the background (light green and "silver") over bare soil. The first row in the foreground was not mulched and plants are showing silverleaf symptoms.

Photo 2. Commercial cucumbers, Parlier CA, grown over reflective mulch (foreground) and over bare soil (background). Both portions of the field were planted on the same day and received the same cultural practices.

Photo 3. Commercial cucumber field (same field shown in Photo 2) in which alternate rows were grown over reflective mulch. Note the "lattice" in the center of the mulch through which plants emerge after germination. See text for explanation and purpose of lattice. The yellow flags (near top of photo) delineate the virus evaluation and yield areas.

TENTATIVE PROGRAM

UC DRIP/MULCH WORKSHOP FOR VEGETABLE CROP PRODUCTION

May/June 1997, KAC

Morning Session - Revolving Stations

Introduction (15 min.) - all groups together

1. Plastic mulches (types available & demonstration of mulch application equipment) (45 min.) [May, Jimenez, Molinar?]

2. Drip irrigation technology (45 min.) [Hartz, Mitchell?]

BREAK (30 min.) - all groups together

3. Fertigation technology (45 min.) [Smith, Jimenez, LeStrange?]

4. Management of aphid, virus, whitefly (45 min.) [Summers, Stapleton]

LUNCH (1 hr.) - all groups together

Afternoon Sessions - Revolving Stations

1. Weed management and ID (25 min.) [Prather, Hembree, LeStrange?]

2. Insect management and ID (25 min.) [Coviello, Goodell, Bentley, Newton, Jimenez, Daane?]

BREAK (15 min.)

3. Solarization (25 min.) [Stapleton, Summers]

4. Specialty Crop Varieties (25 min.) [Jimenez, Molinar, May?]

Wrap-up Session, Questionnaire - all groups together (20 min.)

* Participants will be split into 4 groups of 25.

* Molinar will escort Hmong group with translator? (or do we need this?).

* Extra topics could be addressed through booths or posters during breaks and lunch

* Charge $10 advance registration fee (for lunch) to limit attendance to 100.

* 10 min. between stations; we will need 4 trams for 25 each.